according to certain embodiments of the invention, these waves will share a common transducer, and a common axis of propagation from the transducer. The waves may differ, e.g., in path, mode, frequency, phase, propagation velocity, or wavelength. Therefore, some embodiments according to the present invention provide a reflective array which separates the waves to propagate along differing paths. Another set of embodiments provides a plurality of sets of distinguished reflective arrays, which reflect portions of the waves at differing angles or as waves of differing propagation modes, or both.

[0067] Sensor systems according to the present invention allow superposition of waves producing sets of touch-sensitive waves which are dispersed across the touch area of the substrate having characteristic time delays or other characteristics, and a system for receiving the dispersed waves and determining a characteristic of a touch or wave perturbation. The axes of propagation of one set of waves need not be orthogonal to those of another set. According to the present invention, these sets of non-orthogonal waves may be employed with orthogonal waves. By providing more than one set of these plurality of waves, a position of a touch may be determined using redundant information, e.g., having more information than is necessary to mathematically determine a position, allowing enhanced performance in the presence of noise, interference and shadowing.

[0068] As stated above, the acoustic waves may differ in other properties, including mode, propagation velocity, wavelength, which in general provides two advantages. First, waves having differing properties may have differing sensitivity to environmental conditions and artifacts. Thus, the differential effect on the sensing waves may be used to determine properties of an object in contact with the surface. Further, the differences in the waves may be used to selectively filter the waves, thus providing opportunity to selectively reduce noise or separate potentially interfering waveforms. Waves having differing wavelength in the substrate may be selectively redirected with reflective arrays having physical characteristics corresponding to that wavelength and its axis of propagation.

[0069] In another aspect of the invention, the coordinate system of a sensing wave is non-orthogonal with an output coordinate system. Therefore, a plurality of waves must be analyzed and their position information transformed in order to output a coordinate value. The plurality of waves may also be analyzed for redundancy to verify a touch coordinate, and potentially to resolve ambiguities, perhaps due to multiple touches, in the two dimensional position measurement.

[0070] In an embodiment of the invention, at least three distinct acoustic wave sets are excited, of which analysis of at least two are required in order to detect a two dimensional position of a touch. Therefore, under various circumstances, one or more waves may be ignored or unavailable, yet operation continues. Where at least three are available, the three waves may be analyzed for touch position consistency, artifact or interference, and to determine an optimum output indication of the position of the touch. The analysis of the at least three waves may also include an output of a plurality of simultaneous touch positions.

[0071] According to another embodiment, differing wave modes are induced in the substrate so that regions of low sensitivity employing one propagation mode correspond to regions which have adequate sensitivity employing a different propagation mode. For example, in regions where Rayleigh waves are heavily shadowed due to contamination, a less sensitive backup wave mode, e.g. a horizontally polarized shear mode, may be analyzed for this same region to determine touch data.

[0072] The dual mode operation allows operation with at least two waves, with spatial domain, frequency domain, wave propagation mode or time domain multiplexing. Therefore, signals may be received along differing paths, having differing frequencies, differing wave propagation modes, or differing locations of reception.

[0073] In order to provide waves having differing characteristics from substantially common sensor hardware, the signal from the transducer system may include a number of components. In order to provide frequency mode discrimination, the receiving system must distinguish between various received frequencies. With respect to a plurality of wave modes, either the differing wave modes must be converted to a single mode which excites the transducer, or the transducer must be sensitive to the various modes. With a time domain multiplexing system, readings according to various wave modes are taken sequentially. In order to detect spatially separated waves, a separate transducer may be provided or the waves may be redirected to a common receiving transducer. Where different types of waves are superposed, a perturbation will typically have a different characteristic time delay for the different waves, which is used to distinguish the particular wave.

[0074] Various embodiments of the invention analyze a potential ambiguity in the received waveform. That is, two waves, following different paths, arrive at the same receiving transducer within an indistinguishable time window, and thus a given wave perturbation is potentially attributable to either wave. Therefore, without further information, the controller might not determine, based on the signal of the received wave, which of the two possible paths the touch intersects. According to a subclass of these embodiments, however, a pair of such ambiguous signal perturbations occur. Thus, by analyzing the pair of ambiguous signal perturbations, with reference to a physical model of the sensor and additional information from signals from other wave sets, the position of the perturbation may be determined or predicted, and the ambiguity resolved. Further, as referred to herein, the position may be sensed unambiguously by a pair of acoustic waves emitted along a single set of superposed arrays.

[0075] According to another aspect of the invention, additional information may be obtained from an additional set of superposed arrays, e.g., along another axis. This information may be further employed in determination of the coordinate position. More generally, the present invention encompasses the superposition of reflective arrays, e.g., to scatter a plurality of waves coherently, and a physically superposed array structure.

[0076] Where the waves travel along different paths, often the waves will be directed towards different edges of the substrate. Therefore, for example, two waves may be sensed with two different receiving transducers simultaneously. Advantageously, therefore, a traditional touchscreen system and a touchscreen system with inclined propagation paths